

herbarium, and there is little chance of expansion on the basis of available space in the present administration building. For several years past, temporary expedients have been adopted, and shifts in the sequences of both books and herbarium material made until the possibilities on the basis of present floor space are about exhausted. As noted in the herbarium report below, no further general distributions of reference material into the herbarium are possible, because of the already overcrowded condition of the herbarium cases. It was hoped that this overcrowded condition might be met by the construction of a major building to take the three large botanical libraries and herbaria belonging to Harvard University, the combined collections of the Gray Herbarium, the Arnold Arboretum, and the Farlow Reference Library and Herbarium. To the library resources of these units the extraordinary library facilities of the Museum of Comparative Zoology might be added, thus forming one comprehensive biological library to serve all the biological units of the University, to replace the four large independent libraries now being maintained. This would be a major move, but unfortunately there seems to be little chance of its being consummated for financial reasons. In the meantime it has become imperative to construct a modest addition to the Gray Herbarium building to take care of the critical storage situation there. The solution of the equally pressing space problem at the Arnold Arboretum apparently forces us to consider the possibility of a reasonable addition to the present administration building. In the meantime all space for books, reference material, office space, and accommodations for staff members, resident investigators, visitors, and students is at a premium, with no relief in sight other than some additional building space.

Retirements and Appointments. — As noted in the report for the previous year, Professor Alfred Rehder, Curator of the Herbarium, retired on August 30, 1940, as Associate Professor Emeritus, having reached the age of 75 years, and Dr. J. H. Faull, in charge of Plant Pathology, became Professor Emeritus on the same date. Both individuals served the institution with distinction, the former for a period of forty-two years, and the latter for twelve years. Because of certain adjustments that it was most desirable to make in connection with the genetics situation, it has unfortunately not been possible, as yet, to make a replacement appointment in plant pathology. Professor Rehder continues to occupy his old desk, working on special botanical and nomenclatural problems, but concentrating on the preparation of a bibliographical supplement to his *Manual of Cultivated Trees and*

Shrubs. Dr. A. C. Smith of the New York Botanical Garden staff reported for duty as Curator of the Herbarium on October 1, 1940, succeeding Professor Rehder.

Buildings and Grounds.— The general operations in reference to buildings and grounds have proceeded as in the past few years. The widening of Bussey Street between the Arboretum proper and the Peters Hill section has been completed by the Park Department, while current repairs have been made to road surfaces, walks, and benches. The dry season characteristic of the late summer and early fall of 1939 resulted in a considerable amount of winter injury to certain shrubs, but losses were negligible. The task of preparing the detailed planting maps initiated several years ago has been completed, there now being on file 101 completed panels showing the exact positions of all planted trees and shrubs within the Arboretum limits. As changes are made in the plantings, corresponding alterations are made on these detailed maps and on the card catalogue record, the objective being to keep these maps and records strictly up to date. In checking the maps, which also involved a critical re-identification of many of the planted species, it is revealed that there are now in actual cultivation at the Arnold Arboretum approximately 6500 named species and varieties of hardy ligneous plants.

During the winter, 3400 display labels were prepared and the majority of these were placed in position in the spring. A reserve supply is now available, as with certain changes in the technique of painting and lettering it has become possible greatly to increase the output without a corresponding increase in personnel. A new type of direction sign has been devised, the basis being thick swamp cypress lumber, finished in natural color, with the lettering machine carved. Thirty-one of these were prepared and installed during the year. They have the advantage of being practically unbreakable, and the carved letters cannot be easily obliterated. Furthermore, they can be retained in place summer and winter, without the necessity of removal for repainting, as was necessary with the old smooth surface painted signs which these new ones have replaced. The general design, which is distinctly attractive, has been adopted by the Trustees of Public Reservations for their holdings in Massachusetts.

Through the generosity of Mr. John S. Ames, the Arboretum has fortunately been able to acquire that part of the old quarry site on Centre Street formerly owned by the Rowe Contracting Company. This small triangle situated on the south side of Centre Street, and bounded on one

side by Bussey Street, but separated from the Arboretum property by the abandoned right of way of old Centre Street, has long been more or less an eye sore, marring the approaches to the Arboretum. This tract will be placed in an attractive condition as soon as the City of Boston completes its projected improvement of the juncture of Bussey Street with Centre Street. This was the last piece of privately owned property on the Arboretum side of Centre Street, and it is now naturally pleasing to the Arboretum authorities and the Park Department that it has been acquired for Arboretum purposes.

The popularity of the Arboretum continues to increase, this being reflected in the annually increasing numbers of visitors. A close estimate on Lilac Sunday, May 18, 1941, indicated approximately 44,000 pedestrians in the grounds on that one day. That these numerous visitors are, for the most part, interested in plants, is evidenced by the fact that following this, and other Sundays and holidays at the season of greatest attractiveness in May and June, there are practically no papers or other rubbish left in the grounds, and there are also no evidences whatever of breakage of flowering shrubs and trees, reflecting great credit on the citizens of Boston and vicinity.

Horticulture.— The past winter was not unusually cold and there was a protective covering of snow on the ground much of the time. During the latter part of March, however, after the snow had melted but while the ground was still frozen, several days with high temperatures, strong winds, and low humidity were experienced. These factors combined resulted in more winter injury than in any winter since the severe one of 1933–34. While losses of individual plants were negligible, the killing of branches necessitated a great deal of extra pruning during the spring and early summer. Fortunately, our rhododendrons were not as severely injured as were corresponding plantings in neighboring towns. Some of the conifers suffered rather severely.

During the spring planting season, 389 different species and varieties were added to the permanent collections by transfer from the nursery. Two hundred seven selected *Malus* and *Prunus* hybrids were planted on the Walter Street tract, while on certain hurricane devastated areas, 250 hemlock, 50 white pine, and 40 red pine plants were placed. It is of interest to record the fact that in spite of war conditions, we received in one shipment from England, six weeks in transit, about fifty species of trees, shrubs, and vines, mostly not hitherto represented in American collections. Two shipments of seeds from western China were also received.

The total number of living plants received from institutions in the United States, England, Canada, Hawaii, and Sumatra, was 1500. At the same time, 69 lots of scions were received for propagation work, and 107 packets of seeds, selected from the larger number received, were actually planted in the greenhouse. At the same time 4516 living plants were distributed, 438 lots of scions, and 1103 packets of seeds, this material going to various parts of the United States and Canada, Cuba, Australia, Great Britain and Hungary. From the Yunnan seed accessions, Lu Shan Botanic Garden and the Fan Memorial Institute Yunnan Expeditions, 476 packets of seeds were distributed to various institutions.

A new collection of one hundred twenty-nine named ornamental crab-apples has been installed in the Peters Hill section across the driveway from the old established collection of these attractive plants. This planting is planned to replace the poplar collection which was largely destroyed by the hurricane. Within a few years this should form a very attractive display. The poison ivy eradication campaign has been prosecuted as in the past few years, but much remains to be done on the elimination of this most attractive, yet distinctly noxious plant. In addition to the development of the larger nursery on the Walter Street tract, a definite plan has been developed for renovating the soil in the old nurseries in the Bussey Institution grounds.

In the field of inter-institutional cooperation a part of the propagating grounds has been assigned to the Massachusetts College of Pharmacy, where the institution is installing a comprehensive living collection of medicinal plants.

After several seasons experience in color photography, and because of the unique opportunity offered by the very large collection of living plants available in the Arboretum plantings, a definite plan of recording the characters of selected plants in bloom, in fruit, and in autumn foliage has been developed. For this purpose 35 mm. Kodachrome film is used. During May and June about 300 natural color slides were added to this rapidly increasing collection.

A serious attempt is made to keep the interested public posted on the attractions of the Arboretum and the services it renders. Through articles in the daily press, in weekly and monthly magazines, and in *Arnoldia* (the new name of our Bulletin of Popular Information), and by illustrated lectures to special groups of horticulturally minded people, the more popular and practical phases of the institutional work are presented, and the value of these activities is reflected by the constantly

increasing demands on the Arboretum for material, advice, and assistance, resulting in an ever increasing heavy burden of correspondence.

Cytogenetic Laboratory. — The plant breeding program has been continued with species hybridization in lilacs, apples, cherries, azaleas and roses. Second generation progeny of some of the species hybrids are being grown to provide a wide variety of new types for selection. Naturally cross pollinated species also have provided natural hybrids. Several thousand species hybrids are growing in the propagating beds and nurseries.

The work on X-ray effects has been continued during the past winter. It was found that irradiation had no effect on subsequent X-ray sensitivity. The exponents of dosage curve equations for complex chromosomal aberrations varies from 1 to 2 depending on X-ray intensity.

Mr. Nichols has found frequent spontaneous chromosomal aberrations in root tips from old seed and from seed subjected to high temperatures. Dr. Giles found that spontaneous chromosomal aberrations in *Tradescantia* are much more frequent in triploids than in the diploid and tetraploid parents.

Supplementing the work in genetics as prosecuted in the past few years, the appointment of Dr. P. C. Mangelsdorf on the staff of the Botanical Museum, but financed in part by Arnold Arboretum funds, has enabled us to take part in his extensive corn breeding work, a part of this being centered at the Atkins Institution of the Arnold Arboretum at Soledad, Cienfuegos, Cuba, and a part in our own experimental grounds.

Wood Anatomy. — During the year 789 microscopic slides of wood sections were added to the reference collections, making a total of 24,382 available for study, representing 7,065 species. From various sources, 538 wood specimens were received, forming important additions to this large collection. The totals are now 5,278 species represented by 9,324 individual collections, (preserved material) and 5,959 represented by 11,857 specimens (dried material). In the Icacinaceae study, Professor Bailey and Mr. Howard have continued their anatomical studies, and their work has been supplemented by a study of the pollen characters by Dr. Dahl and of the trichomes and crystals by Mr. Heintzelman. Dr. Heimsch has concluded an extensive study of the comparative anatomy of the secondary xylem of the Geraniales and the Sapindales, and Mr. Reed has initiated a comparative study of the Olacales and Santalales. Dr. Barghoorn has published the last of his series of studies

on the ontogenetic and phylogenetic interpretation of the rays of the gymnosperms and the angiosperms, while Dr. Nast has continued her investigations along similar lines appertaining to wood parenchyma of the angiosperms. To an increasing degree the taxonomists on the Arboretum staff call for assistance in the detailed study of puzzling forms, in an attempt to supplement studies on the basis of the older taxonomic techniques by additional data, often of great significance, appertaining to wood anatomy, pollen and trichome structure.

The Herbarium. — During the year 19,413 mounted specimens were inserted into the herbarium. A total of 26,770 specimens was mounted, some of these being ready for insertion and others being still under study. The total number of specimens now filed in the herbarium is 513,880.

The number of specimens (including duplicates) received by exchange, gift, subsidy, purchase, or for identification was 94,474. Of these 42,591 are from North and South America, 23,232 from India and Indo-China, 12,058 from Polynesia, 10,635 from China, 2,936 from Malaysia, 1,050 from Papuasia, and 1,972 from Africa, the Philippines, Japan, and Australia. Important American collections received were 5,126 specimens collected by Donovan Correll in Louisiana, about 8,300 specimens collected by J. W. Thompson in western North America, about 3,000 specimens collected by G. Martinez-Calderon in Mexico, 3,247 specimens sent by the Universidad Nacional de Tucumán, Argentina, and about 2,000 specimens collected by Verne Grant in Central America. Dr. I. M. Johnston's summer campaign in northern Mexico resulted in his securing about 6,000 specimens. Important Asiatic collections received were about 22,000 specimens (including duplicates) collected in Indo-China by W. T. Tsang (with the cooperation of Lingnan University), about 4,500 specimens collected by T. T. Yü in Yunnan, about 2,000 specimens from western China sent by the Lu-Shan Botanical Garden, about 2,500 specimens from Szechuan, China, sent by Nanking University, and about 12,000 specimens (including duplicates) collected in Fiji by Otto Degener (during the Pacific cruise of the "Cheng Ho," sponsored by Mrs. Anne Archbold).

The total number of specimens distributed by the Arboretum was 42,445, of which 40,497 went to American institutions. Of these, 32,253 were sent in continuation of exchanges, 4,591 as gifts, and 2,161 for identification by specialists. To the Gray Herbarium 10,769 specimens and 1,130 mounted illustrations accompanying descriptions were transferred, while 3,119 specimens were transferred to the Farlow Herbarium and 504 specimens of orchids and numerous orchid descriptions and

illustrations were sent to the Ames Orchid Herbarium at the Botanical Museum. To foreign institutions 1,948 specimens were sent, while books to the equivalent value of 4,146 specimens were exchanged under a special arrangement. Thus the total number of specimens or their equivalent sent out was 47,721. In addition, many thousands of specimens were packed and stored for shipment to European institutions as soon as conditions permit.

Thirty-three loans, totalling 1,275 specimens, were made to 16 American institutions. For study by staff members, 89 loans with a total of 8,142 specimens were received from 28 institutions, for the most part American.

The card catalogue of references to new species and other important literature appertaining to woody plants was increased by 3,300 cards, the total now being 129,119 cards. The collection of negatives representing types and critical specimens now totals 4,047, 21 having been added during the year.

Routine herbarium work included a continuation of the division of large genera into geographic series; all the larger genera are now so arranged and a beginning has been made toward breaking down all the Old World herbarium material in the smaller genera. Insertion of mounted specimens into the herbarium involved considerable shifting, certain families being removed from sequence and placed in the Conifer Room, where a rearrangement had made the coniferous families more compact. This appears to be the last makeshift which will be possible without additional floor space for herbarium expansion. Mounting was more or less limited to collections from regions under study by staff members; many important collections from other regions remain unmounted due to lack of labor and space. During the year many thousands of clippings, typed descriptions, and illustrations were incorporated into the herbarium.

Members of the herbarium staff continued study in their special fields, with the result that numerous manuscripts were prepared for publication and many thousands of routine determinations made. Professor Rehder, who retired from active duty at the end of August, 1940, continued to visit the herbarium daily and to work on a bibliographical supplement to his *Manual of Cultivated Trees and Shrubs*. Dr. Smith, taking up his duties on October 1, 1940, studied special families of the Arboretum's extensive Papuan collections, and undertook preliminary work on the Degener Fijian collection. Dr. Johnston, aided by a grant from the Milton Fund, continued his cooperation with the Carnegie Institution. His summer field work in northern Coahuila, Mexico, was

eminently successful. In addition to extensive work on his own collections, he has continued his identification work on Boraginaceae sent to him by numerous correspondents for study, and has continued the work of identification of the large collections obtained by Professor T. H. Goodspeed of the University of California and his associates in the arid parts of Chile and Peru. Dr. Raup continued his studies of the flora of Arctic America by preparing a report on his MacKenzie Mountains expedition collections of 1939. During the year he has ordered up the very extensive herbarium collections of North American *Salix*, determining several hundred specimens. Through a study of 1,054 specimens from the Peace and Upper Liard River regions sent to him by eight collectors and correspondents, he has added 227 species to his published catalogue of the plants of these regions. Dr. Kobuski has continued his studies of the Theaceae, giving special attention to the American genera. Mr. Palmer has continued his studies of western American plants and his collections of cultivated plants in the Arboretum. Dr. Allen has extended her work on the Lauraceae of the Old World and especially of Papuasia, also making numerous determinations in the genus *Halenia* in America. Dr. Perry has continued to study the extensive series of New Guinea plants received from the Richard Archbold Expeditions and other sources. Dr. Croizat has studied many genera of the Euphorbiaceae, extending his work on this difficult family. Under my supervision, Miss Luetta Chen has continued her study of the genera *Ormosia* and *Sabia*, while Mr. H. L. Li has commenced a study of the Chinese species of Araliaceae. Professor F. P. Metcalf of Lingnan University, with the aid of a Guggenheim Foundation Fellowship, worked at the Arboretum throughout the year in continuation of his work on the Flora of Fukien Province, China. My own work was largely concentrated on the preparation of a comprehensive report on the Captain F. Kingdon Ward collections from Upper Burma (Vernay-Cutting Expedition), a study of the accumulated Indo-China material and certain groups of our very extensive and as yet unnamed Chinese collections, the determination of various Philippine collections, and other accumulations from India, Burma, and Malaysia.

Field Work. — Aside from the work in Mexico prosecuted by Dr. I. M. Johnston, mentioned above, and which will be continued during the summer of 1941, our field work has been largely prosecuted through the granting of modest subsidies to individuals in various countries to enable them to undertake botanical exploration for the Arnold Arboretum. Grants were made during the past year to Señor Guadalupe

Martinez-Calderon for work in Oaxaca, Mexico, Mr. Otto Degener for work in Fiji, Mr. Robert L. Pendleton for work in Thailand, Mr. E. E. Smith for work in Colombia, Mr. J. W. Thompson for work in the Puget Sound region, Mr. James H. Soper for work in Ontario, Dr. T. H. Goodspeed for work in South America, and the National Szechuan University for work in western China. The continued unsettled conditions in China have interfered with the transmission of collections from the field, but extensive collections made in previous years are in safe storage in western China, while certain most important collections were delivered safely, especially the very large Indo-China collections, some 2,800 numbers, with extensive duplicates, made in cooperation with Lingnan University. In Cuba, extensive summer collecting was done by Messrs. Dahl, Howard, Godfrey, and Hodge, the former a staff member of the Division of Biology, the last three graduate students in botany, through assistance and fellowship awards through the Atkins Institution of the Arnold Arboretum.

The Library. — The extent of the library in bound volumes at the end of the fiscal year was 44,812, in unbound volumes several hundred, in pamphlets 12,957, in photographs 18,662, and in nursery catalogues several thousand, representing a net increase for the year of 306 bound volumes, 231 pamphlets and 18 photographs. Six interesting views of Mt. Vernon, photographed by Professor C. S. Sargent, were presented by Mrs. Mary Sargent Potter of New York City. There were added to the catalogue 1130 cards, 530 of them containing bibliographical data, and 1036 slips were added to the files which continue the printed author and subject catalogues of the library. Sixteen new periodicals were acquired and several new exchanges of publications arranged. Many books have been sent out on inter-library loans, and the requests for microfilms and photostats have been more numerous than in previous years. Over 2200 photographs were printed on order for the Montreal Botanical Garden from the negatives made by E. H. Wilson on his expeditions to eastern Asia. The checking of the periodicals of the library for inclusion in the new edition of the Union List of Serials has been completed. Shelf lists have been made for the six alcoves and main corridor in the periodical section, and this has greatly facilitated the work of reference and research. Our large collection of forestry periodicals, numbering approximately 1730 volumes, was deposited in the library of the Harvard Forest at Petersham when Shaler Hall was completed in May. James H. and Ralph Lowell made a gift of 33 books, totaling in value about \$700, in memory of their father, John Lowell,

Harvard 1877. One of our rarest folios, Thornton's "Temple of Flora," was requested as a special loan by the R. H. Macy Company of New York City, for the purpose of reproducing four of its colored plates for sale. The library has received as a gift a set of these excellent reproductions. A list of duplicate publications for sale or exchange has been prepared and will be ready for distribution at an early date.

Atkins Institution of the Arnold Arboretum, Soledad, Cienfuegos, Cuba. — In the planting expansion program a number of palms were moved into the palm section, and several hundred shrubs and trees were transplanted into the newly acquired areas. In the additional area transferred to the garden in February 1939 by the Soledad Sugar Company, the last cane crop has been harvested, so that all the land is now available for planting and development. Naturally with a restricted and modest income, as the planted areas are increased, a higher percentage of the income has to be used for maintenance purposes, so that the expansion of the plantings must of necessity be slow. It has been necessary to extend the nursery area, and Dr. Mangelsdorf's tropical American corn varieties being grown at Soledad have required the preparation of land for this purpose. A new entrance to the gardens was made at the corner of the recent addition below Casa Catalina, thus making the approach more direct. During the year 340 packets of seeds and 759 living plants were received and 433 packets of seeds, 46 living plants, and 53 lots of cuttings were distributed. Mr. Sturrock's book on tropical fruits for southern Florida and Cuba and their uses was published through the cooperation of the Arnold Arboretum in 1940, the income from sales being impounded for the use of the Atkins Institution. About forty individuals enjoyed the hospitality of Harvard House for varying periods of time, the most that have taken advantage of the facilities available in any one year since the institution was organized. These included fourteen representatives of Harvard University working on various botanical and zoological problems. Other educational institutions represented include Wilson College, the University of Colorado, the University of Ohio, Skidmore College, the University of Montreal, Colegio de la Salle, and the University of Havana. Other institutions and organizations represented were the Fairchild Tropical Garden, the New York Botanical Garden, Montreal Botanical Garden, the Cleveland Museum of Natural History, the Ohio Division of Plant Industry, United Fruit Company, and Cuban Agricultural Experiment Station. A group of four, under the leadership of Mr. and Mrs. Warren H. Corning, representing the Cleveland Museum of Natural History, made the Atkins

Institution their headquarters for about a month while collecting natural history material for that institution. Among the Harvard staff members and students were Messrs. Gunckel, Salvin, Dahl, Howard, Hodge, and Godfrey, who spent extended periods in the summer of 1940 working on various botanical problems, and Messrs. Dethier and Greenway, prosecuting zoological work. An extensive series of botanical specimens representing Cuban species was presented by Mr. José Carabia. The comprehensive collecting campaign initiated by Messrs. Dahl, Howard, Godfrey, and Hodge in the summer of 1940 will be continued during the summer of 1941, the objective being to secure the material on which a reasonably comprehensive flora of southern Santa Clara Province may be based.

During the year the Atkins Institution was the fortunate recipient of gifts totalling \$4,426.68 for current expenses and special work, of which \$2,200.00 was an anonymous gift to provide for the reconstruction and enlargement of the greenhouse and neighboring lath house, and for the construction of a public shelter house connecting these two units. Mrs. Edwin F. Atkins provided \$1000.00 for expenses of visiting students and investigators, and \$190.00 for an additional steel herbarium case, while Dr. Thomas Barbour provided \$836.08, of which \$300.00 was for student assistance, the balance for general expenses.

Publications. — As usual the quarterly numbers forming our Journal were issued, the amount of technical material from staff members now taxing the available space. Beginning with the first number for 1941 our Bulletin of Popular Information was renamed *Arnoldia*, thus honoring James Arnold, whose original bequest received in 1872 made possible the establishment of the Arnold Arboretum. As in past years, articles published in the Arboretum serials represent only a part of the work of the staff members. A bibliography of the published writings of the staff and of students working under the supervision of staff members is appended.

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